MICROPHALLUS MINUTUS, A NEW TREMATODE FROM THE AUSTRALIAN WATER RAT

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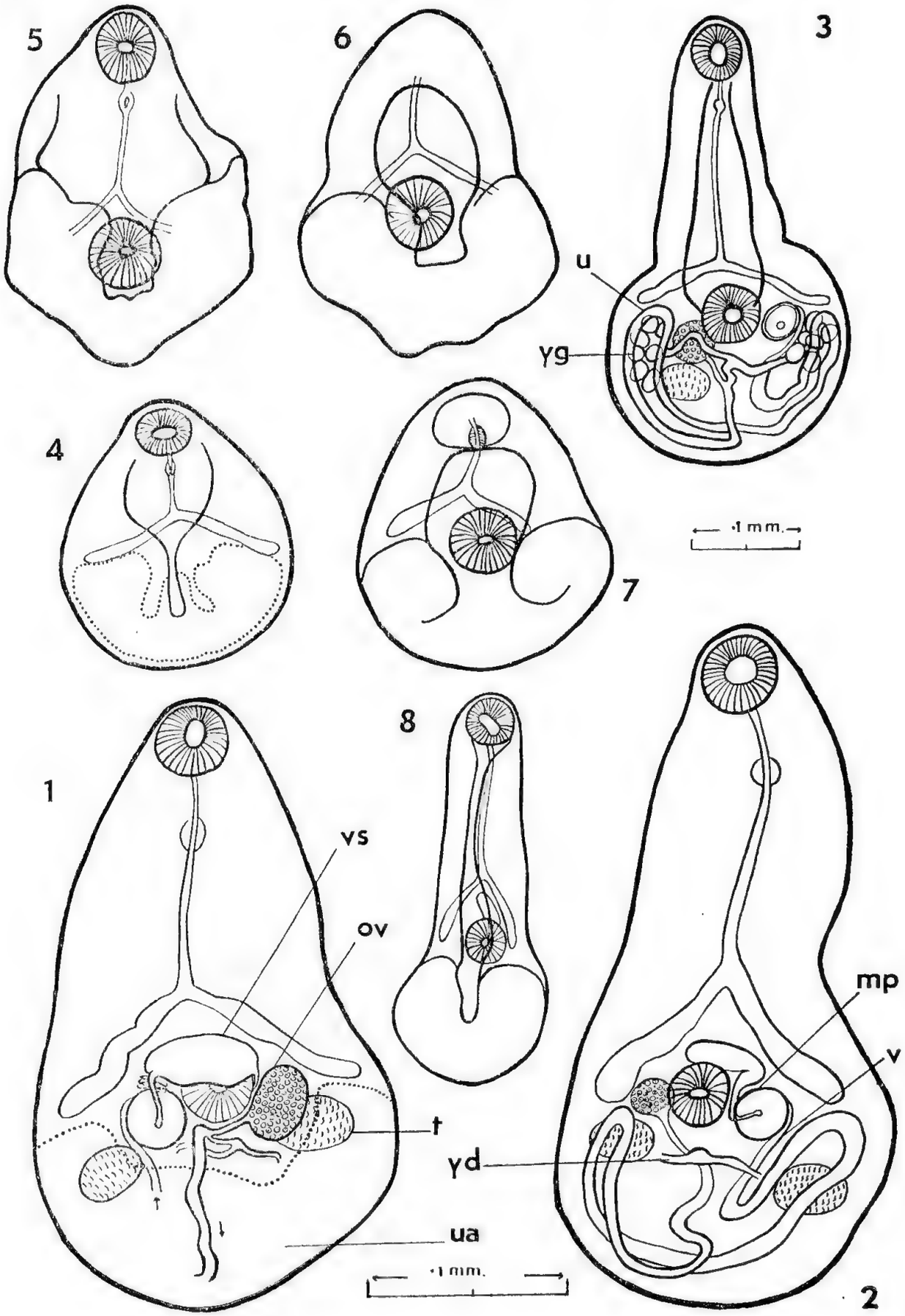
Fig. 1–8.

A very minute trematode, *Microphallus minutus* n.sp., has been found in each of the four water rats, *Hydromys chrysogaster* Geoffroy, var. *fulvolavatus* Gould, examined for parasites between May, 1938, and March, 1947. They were captured along the banks of the Murray River at Tailem Bend. The parasite was not present in one captured in the River Torrens in Adelaide, in July, 1923. The worms occurred usually in great numbers in the upper intestine.

The digestive tract of several of the rodents contained fragments of yabbies, *Cherax destructor;* one had vertebrae and lenses of small fish; and one had fragments of insects and of the mussel, *Hyridella australis*. It is of interest to note that all species of *Microphallus* and closely allied genera whose life history is known, utilize a crustacean for the metacercarial stage.

On some occasions a species of *Plagiorchis* was also present, and in one animal, that found in the Torrens, two specimens of a small diplostome, *Fibricola minor*, were also obtained. This latter trematode was described by Dubois (1936, 513; 1937, 345–8; 1938, 360-2) from material collected from the same host species taken in a suburb of Sydney, New South Wales. The known range of *F. minor* is thus very greatly extended. The two North American species of *Fibricola* whose life cycles are known, viz., *F. cratera* (Baker and Noll, 1915) Dubois 1932, and *F. texensis* Chandler 1942, have been shown to pass through the diplostomulum stage in tadpoles by Cuckler (1940, 32) and Chandler (1942, 156–167) respectively. An account of the anatomy and life cycle of the *Plagiorchis* sp. from *Hydromys* will be published separately.

Microphallus minutus varies considerably in form and dimensions according to the degree of ventral infolding of the lateral edges, and sometimes the anterior and posterior regions of the body as well. The form may thus be pyriform, or resemble a drumstick, or be almost circular in outline. In all cases the posterior third of the worm is considerably widened and it is here that the numerous eggs are located. Occasionally the infoldings along the anterior two-thirds of the body may meet or may even overlap in places, such conditions occurring when a marked drumstick form has been assumed. The largest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specimens observed measured ·41 mm. long by ·22 mm. in maximum breadth, ·35 by ·17 mm., and ·31 mm. by ·19 mm., and did not exhibit any infolding of the body margins. The third mentioned had not yet become ovigerous, though a small structure was present in the ootype and resembled the abnormal eggs containing only vitelline material, mentioned by Cable and Hunninen (1940, 143, pl. iii, fig. 13) as having been seen in *Spelotrema nicolli*. The first worm contained only sixteen eggs and was probably young, while the second contained very abundant eggs. Other worms, all of them egg-bearing, varied in dimensions, the breadth mentioned being the maximum: ·37 mm. by ·14 mm., a drumstick form with a narrow elongate anterior region; ·18 mm. by ·12 mm., with the posterior and postero-lateral regions strongly infolded; ·25 mm. by ·21 mm., an almost round form; ·14 mm. by ·13 mm. and ·187 mm. by ·187 mm., both rounded worms with the anterior, postero-lateral and posterior regions strongly infolded. A young form with narrow anterior and widened posterior regions and with infolded lateral margins and possessing well-developed yolk glands, but devoid of eggs, measured ·287 mm. by ·15 mm.

The anterior part of the body is covered by very minute scale-like spines arranged in quincunx pattern, rather more pronounced ventrally, where the spination extends slightly more posteriorly than on the dorsal surface. On the anterior part of the widened portion of the worm the scaling is smaller and less obvious, but is usually recognizable as far back ventrally as the level of the acetabulum.

The suckers are subequal, the ventrally-directed subcircular oral sucker measuring ·032–·045 mm. in length by ·03–·05 mm. in breadth, and the acetabulum ·03–·05 mm. in diameter. The latter may be sunken or even hidden, in the deep ventral concavity. Its centre lies about midway between the free ends of the crura. The distance of the posterior margin of the acetabulum from the front end of the worm varies to some extent with the degree of contraction of the parasite. In elongate worms the distance is about ·7 of the total body length, whereas in contracted specimens without any anterior infolding, it varies from ·8 to ·6, and in the latter the actual distance between the suckers also varies markedly.

There is a long, narrow prepharynx, ·012–·013 mm. long by ·008–·01 mm. wide, succeeded by a very small pharynx, ·01 by ·012 mm. The oesophagus is relatively very long in relaxed parasites and may be as long as, longer than, or somewhat shorter than, the caeca in such worms. In strongly contracted

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Fig. 1–8. *Microphallus minutus*. 1, dorsal view; 2, ventral view; 3, ventral, sides infolded; 4–7, various specimens with infolded sides and ends; 8, "drumstick" form. Fig. 1, 2, 5, 6, 7 drawn to scale beside 1 and 2; fig. 3, 4, 8 to scale below 3.

ac. acetabulum; mp. male papilla; ov. ovary; t. testis; u. uterus; ua. uterine area, anterior limit shown by dotted lines; v. vagina; vs. vesicula seminalis; yd. yolk duct; yg. yolk gland.

specimens it may be much shorter than the caeca. The caeca are slightly irregular in outline and are 2–3 times as wide as the oesophagus. They diverge widely to terminate just in front of the uterine region. In a few worms the V-shaped excretory bladder with very wide short limbs was recognizable.

The two testes are transversely elliptical, ·027 by ·037 mm., and symmetrically placed in the widest part of the worm, just behind the level of the acetabulum. The right testis lies just behind the ovary and may be in contact with it. The seminal vesicle is a conspicuous, somewhat elliptical organ lying transversely between the crura, and in front of and partly above, the anterior portion of the acetabulum. It measures about ·05 by ·07 mm. in larger worms. The end adjacent to the ovary receives the vas deferens which enters it at almost a right angle, its position being between the ovary and acetabulum. The vesicle becomes suddenly narrowed at its left extremity to become the slender ejaculatory duct which travels posteriorly close to the acetabulum and is surrounded by small prostate glands. The duct then passes directly ventrally through the relatively large circular (in surface view) muscular male copulatory sac or penis which occupies most of the genital atrium. This sac has a diameter of about ·025–·03 mm., i.e. slightly less than that of the acetabulum. The sac lies on the left of the midline at about the same level as, or slightly behind, the midregion of the ventral sucker.

The ovary is rounded, about 0·27 mm. in diameter, and situated laterally in front of the right testis, with its anterior region lying between the acetabulum and the termination of the right caecum. It may overlie partly the testis. The oviduct travels inwards, downwards and posteriorly to receive the yolk duct and then enter the ootype which is median behind the acetabulum. A short, narrow sinuous Laurer's canal was seen in one worm, but a receptaculum seminis was not observed with certainty. Surrounding the ootype are the shell glands. The uterus travels back in a wavy course more or less in the median line, towards the posterior end of the worm, then curves to the right, continuing approximately parallel with the margin of the parasite, and extending forwards below the yolk glands and right testis. It then becomes sharply bent on itself just behind the ovary to form another sinuous loop just in front of the first loop and passes across to the left side, continuing forwards to lie below the yolk glands and left testis. It then becomes folded again, this portion travels inwardly and posteriorly to become bent once more near the median line. It now travels forwards in a more dorsal position between the acetabulum and the male sac, terminating as the vagina at the female pore in the genital atrium, probably just in front of the male sac. In most specimens the uterus is so swollen with eggs that its course is not recognizable and the posterior region of the parasites has become considerably thickened. In such cases the uterine region takes the

form of a U with very wide short limbs, which in some worms converge and almost meet at the tips, and with the swollen terminal part of the organ extending from the base of the U forwards towards the acetabulum before becoming narrowed to form the vagina. Eggs are very numerous and uniform, measuring 19–20μ by 10·5–11·5μ.

There are six or seven rounded yolk follicles on each side, arranged close together and seen only in younger worms. They form a compact vitelline field on each side just behind, or partly below, the testes and above the uterus. From each group a yolk duct travels inwardly in a slightly sinuous course, the two ducts uniting behind the acetabulum to form a common vitelline duct or yolk reservoir which enters the ootype close to the shell gland.

Baer (1943, 69) placed the following Microphalline genera under the synonymy of *Microphallus*: *Monocaecum* Stafford, from a Canadian urodele; and *Spelophallus* Jägersk. and *Spelotrema* Jägersk. from shore birds. *Microphallus* was known previously only from fish. All of these are similar in anatomy in spite of the diversity of hosts. We have accordingly described our species as *Microphallus minutus* rather than *Spelotrema minutum*.

Baer (1943, 64) described *M. gracilis* from a small aquatic insectivore, the shrew-mouse or water shrew, *Neomys fodiens*, from Swiss streams. Our species differs from it in being much smaller; in the relatively longer caeca; in the position and extent of the vitelline follicles; the much larger relative size of the male papilla; the relative sizes of the two suckers; and in its smaller eggs.

Ochi (1928; 1940, 289) described a Japanese species, *M. minus* (i.e. *minor*), whose cercariae became encysted in the muscles of shrimps (*Palaemon*), the adult stage being obtained experimentally from mice, dogs, cat and man, the natural hosts being the dog and the river rat. Ochi's original account (in Japanese) is not available and Baer did not place the species in his key (1943, 70–1).

Africa and Garcia (1935, 257) reported that *Heterophyes brevicaeca* occurred in man in the Philippines. The species was re-examined by Tubangui and Africa (1938, 117) and transferred by them to *Spelotrema*, Baer (1943, 70) subsequently placing it under *Microphallus*. *M. brevicaeca* resembles our species but it is considerably larger, the yolk glands are much more extensive, the ovary is slightly larger than the testes, the prepharynx is shorter, and scales occur in part of the region behind the acetabulum. The natural hosts are man and a tern, *Sterna albifrons*.

The only other member of the Microphallinae known from Australia is *Levinseniella howensis*, described by S. J. Johnston (1917, 220–23) from material which I collected in 1910 from *Charadrius dominicus* on Lord Howe Island. *M. minutus* appears to be smallest adult digenetic trematode as yet known from Australia.

Considerable confusion has occurred concerning the genera, *Microphallus*, *Spelotrema* and *Levinseniella*, attention having been drawn to that affecting the two latter by Rankin (1939, 431–2) and by Cable and Hunninen (1940, 153–4). *Levinsenia* was erected by Stossich in 1892 to include four species of *Distomum*—*opacum, brachysomum, pygmaeum* and *macrophallos*. The second of these was selected by Lühe in 1889 as type of the genus, but Jägerskiöld soon afterwards (1910) designated *Distomum pygmaeum* as type. Ward, who had described *D. opacum* in 1894 from a North American fish, *Amia calva*, gave a further account in 1901 and erected *Microphallus* to receive it and referred to *Levinsenia* as a preoccupied name. Stiles and Hassall (1901) replaced the latter by *Levinseniella*, and a few months later Jägerskiöld (1901) erected *Spelotrema* with *Dist. pygmaeum* as type, and subsequently (1907) founded a new genus on his *Sp. primus*. The characters of *Levinseniella* must be based on its first designated type, i.e. *D. brachysomum*, and since *Spelotrema* was a subsequent renaming of *Levinsenia* Stossich, it must take for its type *brachysomum* instead of *pygmaeum* which has a different, but related structure of the terminal genital ducts, and is admittedly distinct generically from the species now allocated to *Levinseniella* by Rankin (1939) and other authors. Cable and Hunninen (1940, 154) stated "His (i.e. Jägerskiöld's) later (1907) conception of two distinct genera is valid, however, and must be accepted, although he should not have retained for them names which he had regarded previously as synonyms. To suppress *Spelotrema* as a synonym of *Levinseniella*, and propose a new generic name for the species at present allocated to the genus *Spelotrema*, would probably increase rather than diminish the present confusion. For this reason, the writers are inclined to let the matter stand." I do not agree with this conclusion since *Spelotrema* was a renaming of *Levinsenia* and is therefore a synonym of *Levinseniella* which has some months' priority. The species now included under *Spelotrema* by Rankin (1940), Dawes (1946) and other authors must be accommodated elsewhere. Baer (1943, 70) has shown that *Spelotrema* of authors is a synonym of *Microphallus* since the anatomy of the two groups of species is essentially similar. The difference between *Spelotrema* and *Spelophallus* is said to lie in the position of the vaginal opening into the atrium in relation to the male papilla, but Baer (p. 70) regards the two as synonymous and has added Stafford's *Monocaecum* (1903) also.

Microphallus is based on *M. opacus* Ward from *Amia*. Osborn (1919, 123) described *M. ovatus* from another North American fish, *Micropterus*, the species differing from Ward's in possessing very rudimentary caeca and in the relative sizes of the two suckers. Wright (1912, 167) redescribed *M. opacus*, and recently Strandine (1943) examined a very extensive series of Microphallids from the two fish host species and reported a very wide degree of variation in

regard to these features. Strandine showed that in *M. opacus* the caeca might be small as described by Ward, or very small and equally developed, very small and unequal, or only one (either right or left) might be present, or they might be represented merely by a small bilobed sac. He regarded *M. ovatus* as being only a variety of *M. opacus*. Stafford's *Monocaecum baryurum* (1903, 822) from a Canadian urodele suggests a similar degeneration of the caeca which have become represented by a small median sac.

Attempts have been made by us to elucidate the life history of *M. minutus*, but so far without success. Two excellent studies of the life cycles of Microphalline trematodes have been published by American investigators, Cable and Hunninen (1938, 1940) and Rankin (1939a, 1940). Cable and Hunninen dealt with *Spelotrema nicolli* whose cercaria belongs to the *Ubiquita* group and develops in sporocysts in a very small marine gastropod, *Bittium*, the metacercaria occurring in crabs, and the adult (experimentally) in a gull, *Larus argentatus*. They also described an allied cercaria, *C. nassicola*, from another marine gastropod, *Nassa* (1938, 1940). This latter cercaria was shown by Rankin (1940) to be the larva of a Microphallid which he had previously (1939) described as *Cornucopula sippiwissettensis*. Rankin reported that the metacercaria occurred in an amphipod, *Talorchestia*, and the adult (experimentally) in *Larus argentatus*. As Yamaguti had just previously (1939) erected *Gynaecotyla* to receive Microphallids having a similar anatomy, Rankin (1940) recorded his observations on the life history under *Gynaecotyla nassicola*. It should be noted that Baer (1943, 66, 7) has used the name *Gynaecocotyla*. As mentioned above, the known Microphalline cercariae belong to the *Ubiquita* group of monostome Xiphidiocercariae, and the metacercaria occurs in crustaceans. The cyst is spherical or slightly elongate, and thickwalled, and contains the metacercaria whose anterior and posterior regions are folded ventrally, this stage possessing well-developed genitalia (except the uterus) like those of the adult and approaching the adult in size (Rankin 1940, fig. 6; Cable and Hunninen 1940, pl. i, fig. 5–6, pl. ii., fig. 7–8). The adult stage was reached in a shore bird within 12 hours to two days after feeding on infected crustaceans.

It has been noted that, in our species, worms in which egg production had not commenced, were not necessarily smaller than those in which it had; and that egg-bearing specimens were seen in which the body was folded to form a more or less spherical animal, ·14 to ·18 mm. in diameter. In *M. nicolli* the diameter of the cyst was ·05–·5 mm. and the adult ·51–·58 mm. long; in *G. nassicola* the cyst was ·26–·29 mm. in diameter with its wall ·015 mm. thick, and the adults were ·3–·36 mm. long. We suggest that the cyst stage of *M. minutus* probably occurs in the yabbie, *Cherax destructor*, and measures ·2–·3 mm. (perhaps less) in diameter. The only other crustaceans in the Murray River which may be

considered as hosts for the metacercaria are the shrimp (*Paratya australiense*) and prawn (*Palaemon australis*), since the only species of amphipod (*Chiltonia subtenuis*) and crab (*Halicarcinus lacustris*) which occur there are probably too small (and the latter also too uncommon) to serve as food for such a large animal as *Hydromys*.

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Type material has been deposited in the South Australian Museum.

LITERATURE.

Africa, C.M. and Garcia, E. Y. (1935) : *Philippine Jour. Sci.*, lvii, pp. 253–267.

Baer, J. G. (1943) : *Bull. Soc. Neuchat. Sci. Nat.*, lxviii, pp. 33–84.

Cable, R. M. and Hunninen, A. V. (1938) : *Jour. Parasit.*, xxiv, Suppl. Abstr., pp. 29–30.

Cable, R. M. and Hunninen, A. V. (1940) : *Biol. Bull.*, lxxviii, pp. 136–157.

Chandler, A. C. (1942) : *Tr. Amer. Micr. Soc.*, lxi, pp. 156–167.

Cuckler, A. C. (1940) : *Jour. Parasit.*, xxvi, Suppl. 32.

Dawes, B. (1946) : The trematoda, with special reference to British and other European forms. Cambridge.

Dubois, G. (1936) : *Rev. Suisse de Zool*, (xliii), pp. 507–515.

Dubois, G. (1937) : *Ann Parasitol*, xv, pp. 333–353.

Dubois, G. (1938) : Monogr. Strigeida (Trematoda). *Mem. Soc. Neuchat. Sci. Nat.*, vi, 535 pp.

Johnston, S. J. (1917) : *Jour. Proc. Roy. Soc., N.S.W.*, 1 (1916), pp. 187–261.

Ochi, S. J. (1928) : Nihon Byori Zasshi, 18. Abstract in *Jap. Jour. Med. Sci.*, 6, 1, 1940, p. 289.

Osborn, H. L. (1919) : *Jour. Parasit.*, v, pp. 123–7.

Rankin, J. S. (1919) : *Tr. Amer. Micr. Soc.*, lviii, pp. 431–47.

Rankin, J. S. (1939a) : *Jour. Parasit.*, xxv, Suppl. 12.

Rankin, J. S. (1940) : *Biol. Bull.*, lxxix, pp. 439–51.

Stafford, J. (1903) : *Centr. Bakt. Orig.*, xxxiv, pp. 822–30.

Strandine, E. J. (1942) : *Tr. Amer. Micr. Soc.*, lxii, pp. 293–300.

Tubangui, M.A. and Africa, C. M. (1938) : *Philippine Jour. Sci.*, lxvii, pp. 117–127.

Ward, H. B. (1901) : *Tr. Amer. Micr. Soc.*, xxii, pp. 175–187.

Wright, S. (1912) : *Tr. Amer. Micr. Soc.*, xxxi, pp. 167–176.